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BART in the San Francisco Bay Area

Summary of the Final Report of the BART Impact Program

December 1979



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a report by the Metropolitan Transportation Commission



Hotel Claremont, Berkeley, California 94705

The Metropolitan Transportation Commission was established by California law in 1970. Its 19 members represent city and county governments and federal, state and regional agencies that deal with transportation and urban development in the nine counties of the San Francisco Bay Area. MTC's duties include:

- preparing, periodically revising and implementing a regional transportation plan that serves the present and future needs of the nine counties;
- reviewing requests by Bay Area agencies for transportation funds from the state or federal government;
- monitoring the effectiveness and performance of the Bay Area's transit operators.

As a part of its transportation-planning effort, MTC undertook the study of BART that is described in this report. The report is distributed under the sponsorship of the U.S. Department of Transportation and the U.S. Department of Housing and Urban Development. The United States Government assumes no liability for its content, or for the use made thereof.

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Cover photograph: BART train leaves Rockridge station in Oakland. The BART right-of-way here is in the median of Highway 24, the principal highway connection between the suburbs of central Contra Costa County to the east and downtown Oakland and the Bay Bridge—seen in the background with the San Francisco skyline beyond.

Introduction

BART, the San Francisco Bay Area's rapid transit system, began carrying its first passengers in 1972. That same year, the region's Metropolitan Transportation Commission (MTC) began the BART Impact Program, a comprehensive study of the new system's impacts.

The study concentrated primarily on the first five years of BART's operations, 1972-1977, although the historical origins and the development of the proposal for a regional rapid transit system, a chain of decisions and actions going back almost thirty years, were also examined.

The fundamental objective of the BART Impact Program was to analyze the impacts of the BART system to assist in guiding future transportation planning and policy decisions in the Bay Area and in other urban areas. The Program focused on decisions, actions and their results. It investigated what the impacts have been, why they have occurred, how complementary actions might assure greater benefits from the BART system, and how the lessons learned from the BART experience might be useful to other areas and to state and federal officials.

The Impact Program was funded by the U.S. Department of Transportation (DOT) and the U.S. Department of Housing and Urban Development (HUD). MTC administered the program as prime contractor to DOT. Most of the research effort was accomplished by competitively selected subcontractors.

This report summarizes the major findings and conclusions of the Impact Program. It focuses on four principal areas of impact:

- The transportation system and travel behavior
- The environment
- Land use and urban development
- Economics and finance

Detailed information about the Impact Program appears in the reports that are listed in Section 7.

Contents

Overview	2	3 The Environmental Impacts of BART	10
1 BART and Its Setting	5	Impacts During Construction	
BART's Setting		Impacts of BART's Operations	
The BART System		Environmental Impacts on Demography	
Configuration		Implications of Environmental Impacts	
Stations		4 Land Use and Urban Development Impacts	13
Coordinated Development		Office Construction	
Train Operations		Employers' Location Decisions	
Fares		Workers' Location Decisions	
Ticketing		Retailers' and Shoppers' Location Decisions	
Station Interiors		Residential Development Decisions	
BART Trains		Residential Location Decisions	
Capital and Operating Costs		Property Prices and Rents	
2 Transportation and Travel Impacts of BART	7	Speculation	
Characteristics of BART Trips		Implications for Land Use and Urban Development	
Factors in Choice of Travel Mode		5 Economic and Financial Impacts of BART	16
Sources of BART's Ridership		Economic Impacts of Constructing BART	
BART's Patrons		Economic Impacts of Operating BART	
BART's Impacts on Transbay Travel		Incidence of the Tax Burden	
Impacts on Local Buses		BART's Impact on Regional Economic Development	
Implications of Transportation and Travel Impacts		Implications of Economic and Financial Impacts	
Comparing Performance with Expectations		6 Conclusions	18
Future Patronage Growth		7 Technical Literature	20

Overview

The research summarized in this report was completed in 1978. Since that time, several significant events have occurred which have affected BART's ridership. From January 17 to April 5, 1979, BART's Transbay Tube was closed following a fire. During that time, the system continued service on both sides of the Bay and also provided a shuttle-bus service across the Bay Bridge, but daily ridership dropped from about 150,000 to 110,000. Shortly after the Tube reopened, gasoline shortages and a rapid rise in gas prices brought new riders to all of the transit systems in the region, and BART's ridership rose to a daily 165,000. Beginning in July, a labor dispute resulted first in a deterioration of service, with a resultant drop in ridership, and then in the system's being shut down from August 31 to October 5, 1979, when partial service was restored.

All Program research had been completed before these events occurred, and no new work was undertaken to examine their effects. BART's recent history illustrates the variety of events that can affect ridership, as its prior history, described in this report, also does. In this respect, as well as in others, it does not appear that recent events were of a kind to have affected any of the major conclusions of this report.

BART was planned in the 1950's and 1960's in an atmosphere of high hopes and expectations. It was to be automated, fast, comfortable and attractive; a modern, space-age version of the rail transit systems in the leading cities of the world, and an appropriate symbol of the pride with which San Francisco Bay Area residents regard their metropolitan region. BART was expected to increase capacities in the major travel corridors; to encourage a city-centered type of growth; to preserve and enhance the vitality of the major cities and urban subcenters by forestalling an increase in traffic congestion; and to attract an increasing share of the nation's economic growth to the region. BART's planners forecast that a majority of its patrons would be former motorists whose use of the system would decrease traffic congestion and reduce the need for further highway construction. Some of these hopes were well-founded; some were unrealistic; and some may be realized as the system matures, if they are supported by a favorable economic climate, by appropriate governmental policies, and by improvements in BART service.

Those of BART's goals which have been attained in the first few years of its operations are the results of basic design and operating decisions:

- The system has provided a substantial increase in the capacities of the major travel corridors in the central Bay Area. The increase in services planned

for BART within the next few years will permit a level of growth in travel to the cities of San Francisco and Oakland that would otherwise not be possible without increases in other transportation facilities and services. This is particularly important in the central Bay Area where intercity traffic is confined to fairly narrow corridors on bridges, through tunnels, or in urbanized areas along the Bay shore.

- BART has helped to maintain the vitality of the central cities by enabling the corridors in which it operates to accommodate increased travel volumes without increased traffic congestion. The system has absorbed most of the increase in peak period travel in these corridors since its service began.
- BART has been integrated into the Bay Area with a minimum of environmental and social disruption. This is due to careful design and to decisions to place major portions of the system underground or adjacent to other transportation facilities.
- A substantial proportion of BART riders are former motorists. There are a number of reasons for this. The system is attractive and comfortable. It provides direct service to several major business and commercial centers where parking is difficult and expensive. It has decreased transit travel times for many trips between suburban areas and the central cities, and it provides an alternative to driving in congested traffic. While automobile travel times are shorter for most trips than travel via BART, out-of-pocket travel costs by automobile are greater.

BART is a relatively specialized transportation resource in the Bay Area. Its most important travel advantages are for long suburban-to-central-city trips, particularly commute trips made in peak travel periods. About two-thirds of all trips on the system on weekdays are trips to or from work, and about half are trips made during the peak hours.

The system's primary impacts to date have been at the local, rather than the regional level. For example, the economic growth of the area as a whole has not been affected by BART. However, the system has encouraged a city-centered concentration of activities and it has provided access to a larger work force within its service area, two circumstances which can help make an area attractive to business. If BART's service continues to improve, and if traffic congestion or fuel shortages impede travel by automobile in the future, the system's share of the travel market in the region will grow. It might then, through increased use by commuters and for other business travel,

become more important in the region's economy.

BART has affected the spatial distribution of activities in the central Bay Area in a number of ways. In some cases it has influenced urban development patterns directly through its service and its physical presence. In other instances BART has been a catalyst for public policies and projects which have worked with the system's direct effects to influence land uses. Many other factors besides BART have been and are important in shaping Bay Area urban development patterns. They include the price and availability of land, the extensive system of freeways and highways, alternative public transportation services, and the level of market demand for new developments. In other words, BART has been one component of forces influencing individual location and investment decisions which, in turn, give rise to urban development patterns.

BART's most notable land use impacts to date have occurred in downtown San Francisco and Oakland, where the system has been, to a small extent, a direct, and to a larger extent, an indirect influence in the concentration of new office construction in its station areas. For example, in downtown San Francisco, most of the 22.5 million square feet of office space built since 1965 are within 1,500 feet of the four downtown BART stations. Two events for which BART was a catalyst, a \$35 million street beautification program — the Market Street Development Project — and favorable new zoning codes adopted by the city were important forces in focusing this growth in the Market Street area.

In downtown Oakland, where much less new office

space has been added than in San Francisco, about three-fourths of the new construction was within 1,500 feet of the two downtown stations. BART influenced the location decisions for about 80% of this new space, primarily because it enabled the City Center Redevelopment Project, which is adjacent to a BART station, to be expanded. The funds spent for the BART station were used as part of the local credits to obtain matching federal funds for the Project's expansion.

The Program's findings demonstrate that BART has affected land uses only when supportive conditions—such as zoning provisions, community support, and market demand—are present. In the absence of a supportive environment for land use changes, the system has had little influence. For example, several residential or mixed residential and commercial areas around BART stations were downzoned in response to residents' wishes to preserve the existing character of the neighborhoods. In these areas BART has not induced land use changes. Instead, its effect was that of coalescing anti-development sentiment in the communities.

BART has not reversed declining market trends or initiated developments in areas where demand for new developments is absent. For example, a number of BART stations are in areas where housing is deteriorating and where there is little commercial activity. In some of these areas the BART stations are isolated from activity centers by freeway structures, railroad tracks, or land-intensive light industry. No land use changes have occurred in these areas in response to BART. These findings highlight the importance of locating transit stations in areas conducive to development if land use impacts are to be realized.



Hallidie Plaza entrance to Powell St. station in San Francisco. Amenities like this plaza and a street beautification program helped to rejuvenate Market St. A favorable zoning code and market demand were also important in stimulating development in this area.

BART's impacts on Bay Area land uses may become more widespread in the future. There are several reasons to expect these results:

- Large-scale land use changes tend to occur slowly, and BART service is relatively new. Many land use impacts may not yet have had time to develop.
- BART has influenced the decisions of some Bay Area residents about where to live, work and shop. These changes in behavior patterns can be expected to become more widespread as BART's ridership increases. They are then likely to influence decisions about the locations of homes, shops and workplaces.
- Increases in traffic congestion or in the price of gasoline will increase BART's attractiveness as a transportation mode, which in turn will increase the attractiveness of locations near the system's facilities.

BART's patronage has not reached forecast levels, largely because early patronage predictions were based on unrealistic expectations of the level of service to be provided. In 1962, when patronage was predicted to be 259,000 one-way trips per day at full service levels of operations, it was expected that trains would run every 90 seconds wherever three routes merged, as in San Francisco. Today, direct service on one transbay route has not yet been introduced, and where the other two transbay routes merge, trains operate at six-minute intervals. Patronage in late 1978 was 146,000 one-way trips on weekdays, and a recent BART forecast predicts 180,000 trips by 1981.

Train intervals are expected to be reduced to 4½ minutes when the additional transbay route is introduced, but technical limitations which became evident only after operations began have made it unlikely that BART trains will ever run every 90 seconds.

Patronage has also been held down by the system's unreliability. The effects of an unexpectedly high rate of equipment failures have been exacerbated by some features of the system design. For instance, at a complicated three-cornered junction in downtown Oakland, merges of three pairs of routes are effected and any delays there are propagated throughout the system. A systemwide lack of sufficient facilities for removing malfunctioning trains from the main line, such as sidings, causes frequent and widespread delays. Considerable resources have been devoted to solving BART's equipment and design problems, with a marked improvement in such measures as car availability. However, some people still cannot accept the remaining travel-time uncertainty, and therefore do not use BART.

This aspect of the BART experience points to the importance of designing rail transit with sufficient flexibility to manage equipment malfunctions which will

occur on any rail system. It also suggests that funding for new rail transit should be flexible enough to provide for reasonable contingencies. When the contingencies are as extreme and unforeseeable as they were for BART, federal funding should be made available. In BART's case, fund shortages developed because of the unexpectedly high inflation rate during its construction, and cuts had to be made in essential design features, such as sidings. As was noted above, the operational problems resulting from the cutbacks continue to plague the system.

BART's capital cost was \$1.6 billion. Some 80% of the capital costs were funded locally, largely from bond issues secured by local property and sales taxes. The majority of the taxes for paying interest on and retiring the bonds are being paid by households (homeowners and renters). While BART's construction and operations have resulted in a large public debt and a large yearly expenditure of funds, they have not resulted in either a marked stimulation or depression of employment, incomes or sales.

In this respect and others, expenditures for building and operating BART have not resulted in major, long-term economic benefits or burdens in the Bay Area. The economy is varied and the region's resources are generally well utilized. The effects of inflation have resulted in a smaller relative tax burden for debt service on BART's general obligation bonds than originally anticipated. However, the inflationary effects, together with BART's equipment problems, have resulted in an increasing level of operating expenditures. BART's farebox revenues cover about 36% of operating costs, a ratio similar to that for bus operators in the Bay Area.

BART's operating costs, at the 1976 interim level of services, are greater than those of most other rail transit operators as measured by costs for each trip carried. Costs per passenger-mile are approximately equal. This is because the average length of a trip on BART (13 miles) is greater than the typical trip made on most other urban transit systems. BART's operating costs per passenger and per passenger-mile are expected to decrease in the future, in terms of constant dollars, as ridership increases.

The Impact Program found many instances where the design of the system and public policy relative to it had to reconcile or choose between conflicting goals related to cost, accessibility, the environment, and development.

The BART experience illustrates the principle that design and development choices made for one rapid transit system, or even for parts of the same system in different localities, cannot be prescribed for other localities. The Impact Program's findings, which are documented in this and other reports, indicate the consequences of a number of alternatives, but choices must be made on the basis of individual communities' priorities and needs.

1 BART and Its Setting

BART's Setting

The BART District comprises three counties, which have a developed or developable area of 460 square miles. The City and County of San Francisco has been fully developed since the 1960's. Alameda County was two-thirds developed by 1975, and Contra Costa County was about one-half developed. The three counties had a combined population of 2.4 million in 1970. In 1975, about 1 million people lived within 1 mile of BART trackways. BART enters or traverses 14 cities and several unincorporated areas.

Development patterns in the San Francisco Bay Area are shaped by San Francisco Bay and its surrounding hills. North-south corridors of urban development extend along both sides of the Bay, and a corridor runs eastward from Berkeley into the central part of Contra Costa County.

Before World War II, urban growth had been concentrated in San Francisco, Oakland, Berkeley and Richmond — the older cities on the shores of the Bay. During the past 25 years, development has become more dispersed and suburban communities have grown dramatically. New, rapidly growing areas within the District include southern Alameda County and central Contra Costa County.

The nine-county Bay Area's total employment in 1975 was a little more than 2 million. The three BART counties accounted for 53% of that total, while Santa Clara County and San Mateo County represented 36%.

The BART System

Configuration BART's four lines radiate from downtown Oakland. The lines are named for their termini: The Richmond line, the Concord line, the Fremont line and the Daly City line. All of the lines pass through older, medium-density residential and industrial areas; the Concord and Fremont lines extend into newer, low-density suburbs.

The 71-mile system includes 20 miles of tracks in subway tunnels, 24 miles on elevated structures, and 27 miles at ground level. The subsurface sections include the Transbay Tube, the Berkeley Hills Tunnel, and subways in Berkeley, Oakland and San Francisco.

About 85% of BART's trackways lie within, beside or below the rights of way of other transportation routes—arterial streets, highways or other railroads.

In the commercial centers of San Francisco and Oakland, BART provides local subway service. Its stations there are 0.3 to 0.5 miles apart. In the suburbs, where stations are 2 to 4 miles apart, BART serves as a commuter

railway.

Stations There are 34 stations in the system, and 23 of them have parking lots. The lots provide about 20,000 spaces; capacity at individual stations ranges from 240 to 1,600 cars. BART and other transit agencies provide bus service to all stations.

Coordinated Development During BART's construction, several cities carried out municipal-improvement projects that were coordinated with work on BART. These improvements included the development of plazas and pedestrian malls, and the refurbishing of important downtown streets. The redevelopment of Market Street in San Francisco is a noteworthy example. Other examples can be seen in Berkeley and Oakland.

Train Operations BART was opened in five stages, from September 1972 to September 1974. The last section to open was the Transbay Tube, linking Oakland and the East Bay with San Francisco and the West Bay.

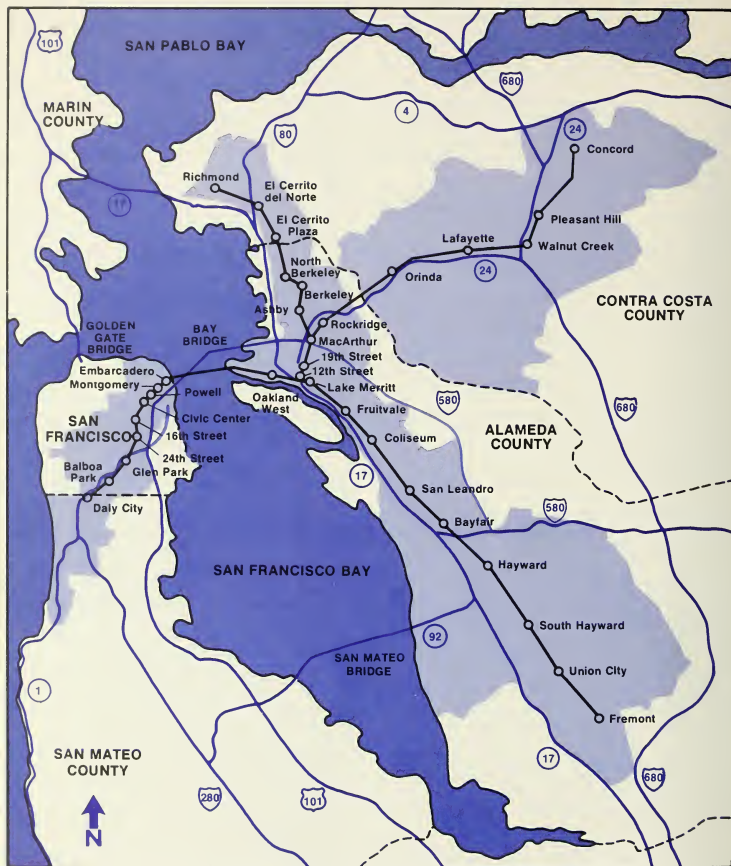
Service is provided until midnight, starting at 6 a.m. every day except Sunday, when it begins at 9 a.m. Week-day evenings (from 6 p.m.) and all day on weekends, trains run on two routes: between Concord and Daly City and between Richmond and Fremont. On weekdays, a third route operates, between Fremont and Daly City. Minimum headways on each route (time between successive trains) are 12 minutes during weekdays, 15 minutes on Saturdays, and 20 minutes on weekday evenings and on Sundays. Along segments where two routes merge (as in San Francisco on weekdays), the headways are halved.

BART plans to expand its service significantly during the next two years by starting direct service between Richmond and Daly City, and by increasing the frequency of trains on all lines during peak-travel periods.

Fares Fares range from \$0.25 to \$1.45, depending upon trip length. Discount fares are available to the physically handicapped, children and persons aged 65 and older.

Ticketing Tickets dispensed by vending machines carry magnetically coded values of up to \$20.00. Fare gates are operated by inserting a ticket. An exit gate determines the fare for a trip from a code recorded on the ticket at the entry station, and deducts it from the ticket value.

Station Interiors BART stations show high standards and individuality of design, enhanced by the use of distinctive materials and works of art. The stations are notably quiet. Noise levels generated by arriving and departing trains are low by current standards of the rapid-transit industry.



primary service area
federal highway
interstate highway

state highway
BART
BART station

0 1 2 3 4 5 m
0 1 2 3 4 5 6 7 8 km

BART Trains The passenger compartment of a BART car is 70 feet long and has 72 seats. Trains are from 3 to 10 cars long. Top operating speed is normally 70 miles an hour. The average speed is 38 miles an hour, including station stops. Each train stops at all stations on its route.

The cars are attractive and comfortable. Their interior features include air-conditioning, carpeting, tinted window glass, upholstered seats and a public address system for announcement of stations and transfers.

Capital and Operating Costs The cost of building and equipping BART was \$1.6 billion.* Half of this amount was raised through the sale of bonds, which are being repaid (principal and interest) through a local property tax. Sources

*About 10% of this was the cost of the Muni-Metro project — a \$160 million modernization of San Francisco's streetcar lines. This project, which is scheduled for completion in 1980, included the undergrounding of part of the surface routes of the streetcar system. Design and construction of the project and of adjacent BART facilities were coordinated. Along lower Market Street, downtown, the two systems occupy two levels of tunnels, BART below Muni-Metro, and share four station mezzanines.

for the remainder of the cost included a sales tax collected in the three BART counties, bridge tolls and federal capital grants. About 80% of capital costs were locally funded.

The original capital cost estimate for BART, published in 1962, totaled \$994 million. The difference (\$642 million) between the estimated and actual costs was due to a variety of factors, but the principal ones were:

- scope and design changes (\$182 million, or 28% of the excess)
- unexpectedly high inflation (\$95 million, or 15% of the excess)
- inflation associated with construction delays (\$321 million, or 50% of the excess)

During the year ended on June 30, 1978, BART's revenue from fares was about \$28 million, or nearly 36% of its total operating cost of \$78 million. About 80% of the resulting deficit was paid from a half-cent sales tax and about 10% from a property tax collected in the three BART counties.

2 Transportation and Travel Impacts of BART

Chief among the goals of those who conceived and planned the BART system were its anticipated effects on regional transportation. The planners hoped to:

- increase travel capacities in major Bay Area travel corridors
- mitigate traffic congestion
- reduce the need for further highway construction
- divert a substantial number of travelers from automobiles

To assess the extent to which these expectations have been met, the Impact Program undertook a twofold study: to observe and measure people's actual transportation choices and travel behavior, and to assess their per-

ceptions of BART and its competitors and their reasons for choosing as they do.

Characteristics of BART Trips

The average BART trip is 13 miles long, costs 75 cents, and takes 46 minutes, including 20 minutes getting to and from the station and waiting for a train. On weekdays, nearly two-thirds of BART's riders are commuting to or from work and another 10% are making school-connected trips.

Nearly half of all BART trips occur during the four peak morning and evening travel hours. During the morning rush hour, BART riders' chief destinations are the four stations in downtown San Francisco. Thus, BART's busiest segment is the Transbay Tube, which handles 60,000 one-way trips each weekday.

Map on the opposite page: All four of BART's lines are in established transportation corridors and are roughly parallel to major Bay Area highways. Approximately 80% of BART's riders begin their journeys at points within the primary service area, which is shown on this map by light blue.

Factors in Choice of Travel Mode

With the advent of BART, some transit travel times for the Bay Area traveler have become shorter. The greatest time savings occur on trips from the suburbs to downtown areas — the type of trip BART was primarily designed to serve. BART is usually faster than the bus, unless the BART ride involves a transfer or a long trip to or from a station. However, on the average, transit travel to major employment centers still takes nearly 15 minutes longer than the same trip by automobile. Only for long commutes to the central cities are transit times competitive with the automobile. BART generally costs less than driving, and when the automobile trip involves parking fees and bridge tolls, BART can provide significant savings. For the majority of trips, however, BART costs more than riding the bus.

In 1977, 2,257 peak-period commuters who used or could use BART were asked to compare the travel time and out-of-pocket cost of their usual mode of travel with an alternative mode for the same trip. They were also asked to assign importance to travel time, cost, comfort, speed and safety and other such factors, and to evaluate BART against its alternative with respect to each factor.

Among commuters who could travel by BART or by bus, 54% selected BART. Ranking factors in the order of their importance to them, they based their decisions on BART's convenience and shorter travel time, as well as a shorter time spent waiting or transferring. Commuters who chose the bus instead of BART reported that they considered the bus more convenient and reliable. Also, the bus trip for them was cheaper and took less time than making the same trip by BART. For each group of commuters, their chosen mode of travel provided the shorter travel time, reflecting the fact that different kinds of trips were being made by each group.

Among commuters who could travel either by BART or auto, 73% elected to drive, citing convenience and a shorter travel time. They also felt the car was more reliable. The BART riders among this group chose BART to save money and avoid the stress of driving in rush hour traffic. For all commuters, the major factors influencing choice of travel mode were time, cost and reliability.

Sources of BART's Ridership

BART's primary service area is identified on the map in this report. Some 80% of BART riders begin their trips in the primary service area. Of the commuters who both live and work in this area, 40% say BART is practical for their work trips. However, only 16% actually use BART for those trips, saying they prefer a faster and more reliable means. An implication of this finding is that BART has a potential for increasing its share of commute trips in the Bay Area by improving service, travel times and reliability.

A 1976 survey of passengers on BART showed that BART has attracted its current patrons from bus and auto in approximately equal numbers. Of those who formerly made the same trip using bus or auto, somewhat less than half formerly rode the bus, while slightly more than half used to make the trip by car. Only 2% of all BART riders stated that they formerly had no available means of transportation to make the trip they now make on BART.

BART's Patrons

The 1976 passenger survey showed that people who ride BART are somewhat younger and better educated than the Bay Area population in general. Nearly half of adult BART riders have four or more years of college. They include a slightly higher percentage of males than females, and they represent households whose income is somewhat higher than average. Generally, BART serves minorities in proportion to their distribution in the area.

The percentage of BART users who are over 64 or who are handicapped is lower than in the population as a whole. This happens despite the 90% discount fare offered to those over sixty-four and a 75% discount for the handicapped. However, older persons in general make fewer trips than younger people, and the trips they do make are usually shorter. Handicapped persons also make fewer trips of all kinds; although BART is accessible to wheelchair users (it was the first transit system in the country to include this feature), handicapped people often find it difficult to reach a station.

BART's Impacts on Transbay Travel

BART has significantly increased the capacity of the central transbay travel corridor and has absorbed most of the growth that has occurred in that corridor since it began transbay service. As stated earlier, the Transbay Tube is BART's busiest segment, carrying 60,000 passengers a day. During the morning rush hours, 90% of the transbay riders are heading for jobs in San Francisco and the tide reverses at the end of the work day.

It is in the transbay corridor that BART shows its greatest effect on bus patronage. Half of BART's transbay riders had previously used Greyhound or AC Transit buses. Six months after the Transbay Tube opened, Greyhound patronage was down nearly 9,000 trips per day and AC Transit patronage was down nearly 19,000. Greyhound, which had wanted to eliminate its transbay service, was allowed to curtail service sharply because of its reduced patronage. AC Transit reduced its weekday transbay mileage by nearly 15% by 1976. AC remains competitive with BART for many transbay trips.

BART has not had a lasting effect on the volume or

speed of traffic in the transbay corridor. When BART began transbay service, Bay Bridge traffic volume was reduced by an amount equal to two years' historical growth. Within two years, traffic volume had returned to the levels that would have been expected if there had been no transbay BART service.

The source of this additional traffic can't be identified with certainty. It might be attributable to local population growth or economic changes during the period under study. It might represent trips that were captured from other routes when BART temporarily relieved congestion on the bridge. Or it might represent induced travel — trips that previously had been discouraged by congestion on the bridge, but that became attractive as soon as BART began to relieve that congestion.

Induced travel is a common phenomenon. Wherever an automobile route is used heavily, there exists a reservoir of trips that people don't make because the route can't accommodate them. If a second route is provided, both routes will draw traffic from this reservoir; and the net loss in traffic by the old route will be considerably less than the gain in traffic by the new route. This result sometimes is surprising to officials and to the public, who reason that the construction of new transportation facilities (such as BART) must substantially reduce the load on others.

Nevertheless, if today BART's transbay riders who used to drive to work switched back to autos, Bay Bridge traffic would increase by 25%.

Impacts on Local Buses

Local bus operators lost some long-distance commuters to BART, and gained riders among people traveling to and from BART stations. Many local bus lines were rerouted to serve BART stations, and service on some of these routes has been increased to improve access to BART. However, feeder bus service to some stations is infrequent.

Some long-distance bus routes operate parallel to and compete with BART. This is one consequence of the institutional setting of Bay Area transit, which differs from that in many other urban areas. Transit services are operated by separate agencies. When BART was planned, no single authority was empowered to coordinate transit services. The Metropolitan Transportation Commission, which was established in 1970, is now actively encouraging the transit operators to implement policies adopted by the Commission for coordinating services and fares in the Bay Area.

Implications of Transportation and Travel Impacts

Comparing BART's Performance with Expectations Although BART has become an important resource for commuters — especially in the transbay travel corridor

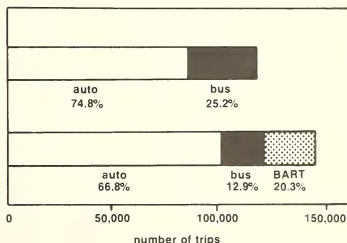
— it hasn't fulfilled some early predictions about its performance and patronage. BART's operating problems have prevented its attaining the service goals which early patronage forecasts assumed. Moreover, many people — professional planners, government officials and members of the general public — clearly anticipated that BART would have a greater impact on the Bay Area than was realistic to expect.

BART's main role in the transportation system of the Bay Area is to carry commuters on relatively long trips between their suburban homes and their workplaces in central cities. This was BART's principal original purpose, which is reflected in many aspects of BART's design and operation.

But commuting trips, by all modes of transportation, represent only 30% of all the trips made in BART's service area. Though BART might capture a substantial fraction of these trips, as indeed it has done, its share of total travel in the region could never appear to be large.

Future Patronage Growth BART's patronage now is limited by its unreliability, by its consequently unpredictable travel times, and by the inadequacy of the parking lots and the local bus service at some of its stations. If these constraints are relieved, BART will attract new patrons from the large group of travelers who already recognize its potential value but can't accept its drawbacks.

BART also will gain new patronage through the growth of population and employment in its service corridors (especially the transbay corridor) and through increases in the stresses, time, and costs of automobile travel.



BART's importance in absorbing new transbay travel. Average weekday travel in the transbay corridor has grown from 112,400 trips in 1973 (the upper bar) to 142,500 trips in 1977-1978 (the lower bar). The difference is 30,100 trips. Nearly all of this new travel has been absorbed by BART.

3 The Environmental Impacts of BART

The Impact Program investigated how the environment of Bay Area residents has been affected by BART's construction, operations and structures. The BART system includes 71 miles of trackway, 34 stations and 23 parking lots. Such a massive and extensive project has the potential for substantial adverse environmental impacts on the areas through which it passes. Nevertheless, BART's overall effects on the environment are primarily neutral. The system was integrated into the Bay Area with minimal environmental disruption by careful planning and design, and by placing most BART facilities within or adjacent to other transportation rights-of-way. The degree to which impacts occur, and the responses to them, vary throughout the system.

Impacts During Construction

BART's most significant construction impacts were on people, rather than the natural environment. The few nonurbanized areas selected for BART trackways were not ecologically sensitive, and in those areas the BART right-of-way was often located adjacent to an existing highway or railroad. Where it was necessary, measures such as slope stabilization and runoff drainage were adequate to minimize changes to the natural environment along the tracks and in station areas.

People living and working near BART's construction operations, however, were affected, sometimes adversely. The intensity and duration of those effects depended on the kind of structure being built and on the construction methods used.

The greatest inconvenience occurred in the cities where BART was placed underground. BART's subways in San Francisco, Oakland and Berkeley were built using both boring and cut-and-cover construction methods. The effects of boring were not generally significant, but cut-and-cover work disrupted traffic, reduced parking spaces, and created an irritating amount of dirt and noise. Cut-and-cover construction in downtown areas lasted from about two years (in Berkeley) to five years (in San Francisco). Construction in San Francisco was complicated and prolonged by the redevelopment of Market Street and by related work.

Little information exists to show how local businesses were affected by BART's downtown construction work. Newspaper articles and other anecdotal sources suggest that some retail stores lost revenues, because construction operations interfered with the movement of pedestrians and with the parking of automobiles on local streets in commercial districts.

Sales tax data from stores near BART construction

sites support these suggestions.

Among merchants who were interviewed after construction had been completed, about half reported that their sales had declined during the construction period; and about half of those attributed the decline to the BART work.

BART and its contractors used several methods to try to minimize negative construction impacts. They worked with local governments to manage traffic flow and used construction methods which reduced dirt, disruption and noise. They operated a community-relations program that kept residents and businessmen informed of work schedules and responded to complaints of nuisance and damage.

Approximately 3,000 housing units were demolished during BART's construction, mostly in suburban areas to make way for station parking lots. (A similar number of households were displaced by a 3½ mile segment of a freeway, Highway 24 in Oakland.)

BART made no substantial effort at relocating the buildings' residents, and this created hardship for some people who could not easily search for new housing. Houses were pulled down quickly after they were vacated, sometimes while some neighboring buildings were still occupied.

Aboveground station and trackway construction impacts on nearby residents differed, depending on the type of structure being built. Station construction lasted from six to twelve months, subjecting local residents to the dirt, noise and dust that accompany any such project. Trackway construction took less time, ranging from a few weeks to two months, and its adverse impacts were less irritating and disrupting.

Impacts of BART's Operations

The most significant direct environmental impact of BART's operations is noise near some aboveground trackways. The greatest indirect impacts include the visual impacts of BART structures, and station-area traffic congestion and parking problems.

Train noise is loudest when trains reach high speeds on aerial sections or encounter switches, tunnel openings, or overpasses. Noise is most noticeable along seven miles of aerial trackways where there are residences close to the line and where the background noise level is low. There is no noise impact near stations, since BART trains are moving slowly there.

In 1976, the Impact Program conducted a survey of residents at potential problem sites near BART. From 41% to 71% of the people who live at various survey sites very close to aerial trackways rated train noise heard inside their homes as "bad." At a site in Oakland where the outside noise level was already high before BART trains began running, the percentage was only 17.

Residents near aerial trackways also reported a loss of privacy, since passengers can sometimes look directly into their yards and houses from the trains. Some also complained of blocked views and of objectionable shadows cast by the elevated structure.

Some 10% of survey respondents reported that they had considered moving and that BART was at least part of the reason. Since they were still present, they had not acted on their inclination. No estimate is available of how many people might have actually moved because of BART.

Professional urban designers who evaluated the visual impacts of BART structures for the Impact Program determined that in commercial and industrial settings, BART's stations are generally unobtrusive. In residential districts, the visual impacts of stations vary. Some stations have small aboveground structures and several small, well-landscaped parking lots that are screened from nearby residences. These are much less obtrusive than the stations with large, visually open expanses of parking, which were judged to be inappropriate in a residential setting.

In contrast to the professional evaluations, local residents found the visual impacts of BART stations either pleasing or were indifferent to them. For example, 40% of the residents interviewed who lived near the Daly City station thought the station had improved the appearance of their neighborhood, and most of the rest said the station had no significant visual impact. While 25% of the respondents who live near the Concord station said the station had a negative impact on their neighborhood, 60% in the same area perceived no effect at all, and the rest said they found the station pleasing.

In Albany and El Cerrito, where the trackway is elevated and runs through residential neighborhoods, the adverse visual impacts of the BART structure are partially offset by the positive effect of a 2.7-mile-long linear park. This is a landscaped, planted area under the trackway that is popular with local residents and well-used as a park.

Several suburban station areas have suffered from rush-hour traffic congestion and overflowing parking lots. (Downtown stations, which do not have parking lots, are not affected by this problem.)

The problems are most severe at end-of-the-line stations, such as Daly City and Concord, which are used

by patrons from large feeder areas. Strategies to cope with the parking problem have included improving access by expanding bus service to the stations, increasing the parking capacity at some stations, and adopting regulations that reserve street parking for local residents. At Daly City, all three of these expedients were employed, and have alleviated the parking problem for local residents and commuters. Nonetheless, access to this station and others still presents problems that await solution.

BART's only regional environmental impact has been a small reduction in the three BART counties in the emission of air pollutants from automobiles, estimated at just over 2% for a patronage level of 150,000 trips per day. BART itself is the source of a minuscule amount of air pollution, resulting from the generation of the electrical power it uses.

In view of the small fraction of total trips in its service area carried by BART, it can never have a large impact on air quality, even if its patronage doubles. According to the region's Air Quality Maintenance Plan, over 90% of the improvement needed in the Bay Area to meet government air quality standards must come from controls on industrial sources and automobile emissions. The rest of the improvement must come from measures that will reduce automobile travel. These measures include the diversion of trips from automobiles to BART and other elements in the regional transit system.

Environmental Impacts on Demography

Although BART seems to influence some people's decisions about where to move when they seek new residences, there is no evidence that BART induces changes in the demographic features of a neighborhood. During the construction period, adverse impacts were greatest near urban subway sites, and a substantial number of people affected were poor or members of ethnic minorities. Currently, the people most affected by BART structures and operations are predominantly middle-income suburban families who live near aboveground stations and trackways. Since BART stations and trackways are underground in the urban centers, neither structures nor operations have much impact on central city residents.

About 5,000 people live near trackways that produce significant noise or other adverse effects; 8,000 are affected by traffic congestion and overflow parking caused by BART stations. These groups together constitute 1.3% of the 1 million people who live within 1 mile of BART.

Implications of Environmental Impacts

With careful planning, many of the adverse impacts resulting from a rail-transit system's construction and operations can be minimized, or avoided altogether. A carefully planned rail system has far fewer negative impacts

Central Berkeley station. The train platform and underground concourse reflect the belief of BART's planners that pleasant surroundings and high standards of design and construction would help in drawing commuters out of private automobiles and into trains.



than the highways and automobiles needed to move the same number of people to the same places. Negative impacts do exist, but planners can take steps to reduce them.

A long construction period will be difficult for the individuals and businesses who must suffer increased noise, dirt, obstructions and other problems which accompany the building process. Providing alternative means of transportation through blocked areas, using rapid construction methods, providing information to neighbors about work schedules, and establishing a system for responding quickly to complaints can help reduce the adverse impacts. If people must be displaced from their homes to make way for new construction, help should be available to those who need it in finding suitable new housing.

The design and placement of stations and trackways entails some important compromises. A station is useful only if people can get to it quickly and conveniently, but

too much traffic disturbs the surrounding neighborhood. Good feeder bus service to stations—which is not always economically feasible in low-density suburbs—combined with adequate and well-designed parking facilities, can help reduce negative effects on neighborhoods. Planners should also work closely with local officials to design methods of handling the increased traffic so it does not become a problem for station area residents.

Underground trackways, sound barriers, and wide rights of way decrease the possibility that noise and trackway structures will trouble nearby neighborhoods. The most effective way to avoid adverse impacts during operations is to place as much of the system as possible underground, but subway construction is considerably more expensive than aboveground construction. Each community that plans a rapid transit system will be faced with such choices between the need to reduce adverse effects and the associated costs.

4 Land Use and Urban Development Impacts

BART's planners expected that the transit system would increase the desirability of residential and business districts near BART stations for the development of new businesses, industry and housing.

Behind this expectation lay the assumption that transportation is influential in people's decisions about where to live, work and do business. Thus, a convenient, inexpensive and efficient transit system might make a location more appealing. The Impact Program sought to determine whether BART has, in fact, influenced Bay Area land use and development patterns and, most importantly, how much.

Since most land use changes occur over a period of many years, it is too early to determine what BART's ultimate impacts might be. Further, BART's influences cannot be easily isolated from the many other factors which affect people's location decisions. It is clear, however, that BART has worked with other factors to influence Bay Area land use even at this early date.

The Impact Program investigated and analyzed BART's effects on the spatial distribution of construction and on other aspects of urbanization: workplace and residence location decisions, development decisions, shopping patterns, retail sales, land use near BART stations, real estate speculation and property prices and rents.

Office Construction

BART has stimulated relatively little new urban development, but the transit system seems to have influenced the direction and pace of an already existing growth pattern. This can be seen most clearly in the San Francisco and Oakland urban centers.

After the decision to build BART was made, San Francisco set out to transform the deteriorating Market Street and South-of-Market areas into a prestigious business district. The BART line which runs under Market Street now carries commuters from the East Bay, and West Bay commuters from the south, into this new business district. Many of the new office buildings are within walking distance of underground BART stations.

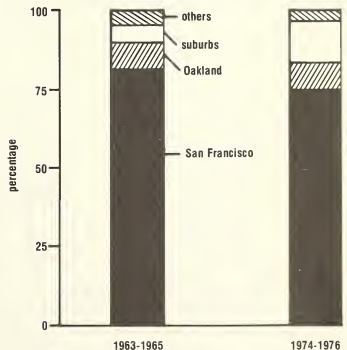
To encourage development in downtown station areas, San Francisco enacted zoning regulations providing incentives to construct buildings with direct entries to, or located near, a BART station. In part in response to BART, the city also undertook a \$35 million street beautification effort, the Market Street Development Project.

More than 21 million square feet of office space was

added in downtown San Francisco between 1960 and 1976. Several buildings currently under construction and others planned will sustain that pace at least through 1980. Most new development in San Francisco has occurred on or near Market Street in the area where BART's four downtown stations are located. The Market Street area's share of new office construction in the city increased from virtually none in the years 1960-1962 to 88% in the years 1974-1977.

BART's influence on this development was largely indirect, through the rezoning and the street beautification it catalyzed. Other factors unrelated to BART were also important, such as a vigorous demand for space, the availability of redevelopable land along Market Street and its favorable cost relative to other nearby areas, and the existence of a concentrated network of bus and streetcar transit lines already serving the area. Knowledgeable informants in San Francisco cited BART as one of several direct influences in the location of about 10% of the new space in the area.

Oakland's City Center Redevelopment Project, originally a small six-block project, was expanded to include a BART station. BART funds helped initiate a street beautification project in the redevelopment area. As in San Francisco, Oakland enacted new zoning and incentives policies in conjunction with BART. To date,



Distribution of new office construction in the BART counties. From the mid-1960's to the mid-1970's, the share of office construction in the suburbs more than doubled. At the same time, expenditures for new construction in the cities grew by 140%.

however, there has been relatively little new construction in downtown Oakland, although what new space has been built is located in BART station areas. Oakland's recent share of office construction in the BART counties is about 8%, compared to 75% for San Francisco.

Richmond, Berkeley and Walnut Creek also experienced some new office construction near BART stations, although on a much smaller scale than in the central cities. According to knowledgeable observers, BART played only a limited role in this new development.

Employers' Location Decisions

Public transportation does not appear to play much of a role in Bay Area employers' location decisions, nor does it stimulate new construction in economically declining communities.

Only 13 out of 50 employers interviewed for this study indicated that they considered public transportation when they decided where to locate their businesses. Because of the highly developed transportation system in the Bay Area apart from BART, when transportation is considered BART plays only a limited role in such decisions. Among the group that did consider transit access, five major employers stated that their relocation decisions were directly influenced by BART. Three out of the five are government agencies, mandated to consider such access. One of the government facilities, the Social Security Administration's Western Program Center in Richmond, was the only major employer to relocate in a declining area, one of the reasons being the location of a BART station near the chosen site.

Workers' Location Decisions

BART's influence is greater on workers than on employers. A substantial number of workers interviewed for this study, about 25%, said they consider BART when seeking new jobs. (Because the sample was weighted so that half of the respondents were BART riders, the BART influence is overstated.) While BART is only one of many factors they consider, some workers see a near-station location as among a potential job's advantages, and this is particularly true for workers who commute from the East Bay to San Francisco. However, a number of workers told interviewers they did not use BART because they found it difficult to reach a station from their homes, and because the service was not frequent or reliable enough.

Retailers' and Shoppers' Location Decisions

BART has had little effect on retailers' location decisions, despite the fact that public transportation is usually high on the list of considerations for retailers' location choices (as with employers, other transit besides

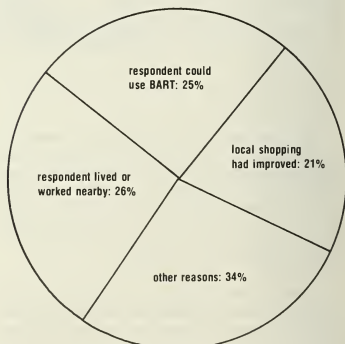
BART is usually available). However, there is interview evidence that some shoppers (about 7% in San Francisco and Walnut Creek) choose their shopping location because of the availability of BART service. Since weekend service began only near the end of this study, BART's ultimate effects on retail sales cannot yet be predicted.

Residential Development Decisions

For a number of reasons, the new clusters of high-density residential development expected in station areas have failed to materialize. Currently, in the suburban areas, Bay Area families prefer single-family dwellings. There is little market demand for multi-family units, especially among the middle-income commuters primarily served by BART.

Although a number of local governments changed zoning regulations to encourage higher density construction in station areas, little such development has occurred. Perhaps more importantly, some communities fearing changes that would alter the character of their neighborhoods, influenced local governments to restrict high-density housing and commercial development near station sites.

BART seems to have influenced the direction and pace of some residential growth. In two suburban fringe areas—north-central Contra Costa County and southwestern Alameda County—that previously were beyond reasonable commuting distance to urban employment centers, BART may have helped accelerate residential development by reducing travel times to San Francisco and Oakland.



BART's importance in shoppers' location decisions. This graph shows reasons cited by shoppers who had increased their use of shopping areas served by BART. Respondents were part of a 1977 survey of 500 shoppers chosen so that half of them were BART riders.

BART also influenced the location, timing and density decisions for six large housing developments — a total of 3500 units — in its service area. Two-thirds of 26 developers interviewed in this study reported that they consider BART when they decide where to build, and half of them said they would pay a premium for land in BART station areas.

Residential Location Decisions

BART appears to be one of the factors people consider when they decide where to move, although the transit system does not affect people's initial decisions to change residences. The transit system is considered more often by home-buyers than by renters, and those who do not use it also consider BART when they purchase homes. Home-buyers make a substantial investment in their residences, and it appears that they see BART as a way of protecting that investment should automobile travel become increasingly difficult or expensive.

Unlike commercial districts, residential areas need not be within walking distance of a station to be influenced by BART. While commuters want to be able to walk to work from a station, they consider the transit system convenient if they can drive to a station from their homes in ten minutes or less. BART's impact is greatest on the location decisions of suburban commuters. Central city

residents, who are served by other forms of public transportation, seldom consider BART when they make decisions about where to live or work.

Property Prices and Rents

Contrary to planners' original expectations, there is no evidence of a permanent BART-created impact on property prices or rents.

While BART may have made some residential locations more desirable, it has had a negative effect on a few neighborhoods. Residents near some stations reported that they were annoyed by station parking lots with parking overflowing into the neighboring streets. Others, near aerial trackways, complained of increased noise and trackway structures which block their views or reduce their privacy. However, no evidence was found that people actually moved because of problems associated with BART, nor have BART impacts reduced property values in most problem areas. There was some indication of a small reduction in residential sales prices close to the Walnut Creek Station.

Before service began, prices of single-family homes rose in three of four station areas studied, and part of the increase was attributable to the valuation of the anticipated



San Francisco-bound train arriving at Orinda station. Beyond the parking lot, commuter traffic streams west on Highway 24. BART's impact on location decisions is greatest among commuters buying homes in suburban areas like this one in central Contra Costa County.

BART service. In a fourth study area, prices were unaffected. After service began, and it didn't measure up to expectations, the BART-related price increases disappeared.

Residential rents appear to have been generally unaffected by BART. The only exception noted is Walnut Creek, where there is some indication that minor rent increases might be BART-related.

Office rents increased near some BART stations in San Francisco, Walnut Creek and Oakland, but it is difficult to isolate BART's influence from the other factors which affect such changes. Generally, BART's influence on property prices and rents has been negligible.

Speculation

Speculation was defined for this study as the purchase and holding of property for the sole purpose of BART-related price appreciation. During the construction period, some speculation occurred in 13 of 17 station areas studied by the Impact Program, focusing on small commercial and residential properties. However, as construction dragged on and service proved to be less reliable and frequent than originally expected, speculation diminished.

Implications for Land Use and Urban Development

BART works together with other forces to affect location and investment decisions which, in turn, influence land use and urban development patterns. The transit system's most visible impact can be seen in San Francisco, where BART played an observable role in a major redevelopment effort.

To date, most BART impacts have been relatively localized. The transit system has not had a discernible influence on regional, as distinct from local, land use and growth patterns.

BART has been a factor in the planning and imple-

menting of redevelopment projects, has influenced zoning changes, and affected the timing and locational decisions of some commercial and residential development projects. While the transit system has not stimulated new development or encouraged the upgrading of economically declining communities, it may have helped to counteract pressures for decentralization by improving access to urban centers.

Whether BART's impacts on land use increase substantially in the future depends, in part, on a number of factors. As mentioned elsewhere, increasing reliability and service, combined with increasing traffic congestion in Bay Area travel corridors, may lead to increased patronage and hence to new demands for housing in BART station areas. As land becomes more scarce and expensive, the current preference for single-family residences might yield to economic realities and demand for multi-family housing will grow. In that case, more Bay Area communities will be likely to act to encourage station-area development.

Although BART has not yet significantly affected employers' and retailers' location decisions, the increased accessibility it provides to the central cities might help to strengthen their preeminence as employment centers. As more people come to depend on BART to reach their jobs, near-station locations are likely to become more desirable for commercial development and property prices will increase accordingly. This might also occur near those suburban stations where developable land can still be obtained.

BART affected land uses significantly only where market demand, supportive public policies, community support, and a variety of other factors were present. To maximize positive impacts anywhere, transit planners must work closely on initial planning and route selection with local governments, developers, financial institutions, and community representatives. Careful coordination of land use and transit plans can help planners avoid unrealistic expectations, develop community support, and better fit the transit system to the real needs of its service region.

5 Economic and Financial Impacts of BART

The Impact Program's investigation of the regional economic and financial impacts of BART included the impacts of the construction and operation of BART on regional income and employment, on the distribution of the related tax burden and on local public financing. The role in regional economic activities and development of the transportation service provided by BART was also examined.

An early prospectus for BART expressed the expectation that the transit system would "improve the area's living and working conditions, economic efficiency and availability of workers, and attract a larger share of the nation's further growth." While the Bay Area economic climate is vigorous, there is no evidence that BART substantially influenced its growth. Generally, BART's effects on the Bay Area's economy have been small.

The Economic Impacts of Constructing BART

Of the \$1.6 billion cost of constructing BART, \$1.2 billion was spent within the nine-county Bay Area. When the indirect and induced expenditures generated by the direct costs are added, total sales and income amount to \$3.1 billion spent during the 13-year construction and procurement period, 1964 to 1976. In the year of the greatest expenditure, 1969, BART's contribution to the regional economy was about one-half of one percent of the gross regional product. Overall, the construction money spent in the region had a modest impact on the regional economy.

The story on employment is similar. BART's construction directly and indirectly generated 75,000 person-years of employment. BART's direct peak-year employment was 5,000 construction jobs, 6% of all construction employment in the region, 0.3% of total regional employment.

During the construction period, which predated affirmative action programs, minority workers constituted 36% of BART's labor force, compared to their being only 22% of the area's urban work force. More than two-thirds of this large representation of minority workers was employed as unskilled labor. By contrast, minorities were underrepresented in the skilled crafts jobs. BART is credited by expert observers with having introduced the concept of equal employment opportunity to the local construction industry for the first time on a large scale.

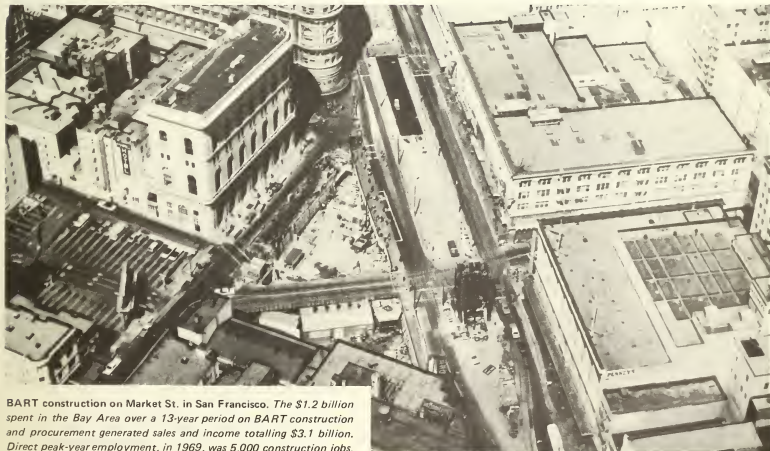
The Economic Impacts of Operating BART

The financing plan originally issued for BART included the expectation that the system would pay its own way. During the year ending June 30, 1978, BART's operating expenses were about \$78 million and its fares covered approximately 36% of operating costs — comparable to the figures for the other transit operators in the district, San Francisco's Muni and the East Bay's AC Transit. BART's operating deficit is funded mainly by a one-half percent sales tax in its service area, and secondarily by property tax revenues and federal funding.

A study of BART's impact on the employment of minorities and women was done in 1976, when BART employed almost 1,900 people. Comparing BART and the local bus operators, all had high minority employment, 40-50% of the work force, but BART employed a substantially higher percentage of women, 19% compared to 9% for the bus companies. At BART, the average salaries of minorities and women were also substantially higher than in the bus companies. This reflected differences in assignments to job categories more than differences in wage scales.

Incidence of the Tax Burden

The majority of local taxes used to repay BART's capital costs and to subsidize its operations fall on households, in the form of property taxes (directly for home-



BART construction on Market St. in San Francisco. The \$1.2 billion spent in the Bay Area over a 13-year period on BART construction and procurement generated sales and income totalling \$3.1 billion. Direct peak-year employment, in 1969, was 5,000 construction jobs.

owners and indirectly for renters) and sales taxes. Property taxes for BART represented about 4% of the total property tax bill in most BART District communities in 1976. An affluent family of four paid a total of about \$153 in sales and property taxes to support BART's capital and operating costs. A poverty-level family of four paid about \$21. The tax burden distributions for capital and operating cost taxes are similar, although the amount paid in taxes to support operations is only one-half to one-third as much as for the capital costs. As a family's income decreases, the BART taxes represent a progressively greater percentage of that income. In this respect the BART taxes tend to be regressive, as are taxes for other public services supported by the same tax base.

BART's Impact on Regional Economic Development

To assess BART's effect on the region's overall industrial growth, employment shifts in 66 Bay Area industries or industry groups were analyzed relative to 23 other metropolitan areas. This analysis of employment statistics indicated that five industry groups within the San Francisco Bay Area — government, central office activity, services, financing and manufacturing — have grown faster than can be explained by national or industry trends since 1962, when BART's implementation became predictable. However, extensive interviews within these industries failed to disclose any BART influence on this growth.

The Bay Area enjoys a positive reputation as a dynamic growth center with many advantages which can influence corporate location decisions. Further, a well-developed transportation system existed in the region

before BART improved the average access time to employment centers for a portion of the work force. There is no evidence that through that improvement in transit service BART played any measurable role in the Bay Area's overall industrial growth.

Implications of Economic and Financial Impacts

Expenditures for building and operating BART have not resulted in major, long-term economic benefits or burdens in the Bay Area. The economy in the region is varied and the region's resources are generally well utilized. Therefore, while BART construction and operations have resulted in a large public debt and a large yearly expenditure of funds, they have not resulted in a marked stimulation or depression of employment, income and sales. The effects of inflation have resulted in a smaller relative tax burden for debt service on BART bonds than originally anticipated. However, the inflationary effects, together with BART's equipment problems, have resulted in an increasing level of operating expenditures.

The BART experience suggests that transportation can contribute to a region's economic growth only as one factor among many. A transit system like BART may influence the locational decisions of businesses within its service area, as the Impact Program's investigation of urban development showed. But BART neither altered the economic climate of the Bay Area during its construction period nor contributed significantly to the subsequent economic growth of the region — in short, BART generated very little of the major regional economic benefits expected by its proponents.

6 Conclusions

The BART experience points to the importance of regionwide agreement on consistent transportation and development goals, and the adoption of public policies that will support those goals. Included among such policies should be:

- Close coordination of land use and transit planning if a rail system is intended to produce significant land use impacts.
- Community support for higher density development where high-density nodes of residential and commercial development in station areas are desired.
- Opportunities for public improvements which can enhance the urban development impacts of a rail transit system should be identified, funded and scheduled to coincide with the construction of the

system to minimize disruption. Such improvements can provide the necessary support for new development in the transit station areas.

- Station area sites must be appropriately zoned, though this does not mean that all stations necessarily must have high density or extensive redevelopment.
- Community support for plans for the design and location of rail transit facilities is necessary. Provision should be made, nevertheless, for changes to the system design and possible cost increases and construction delays when contracts are negotiated with public utilities and with communities through which the system will pass.
- The environmental impacts of a massive, extensive new rail transit system can be minimized, as BART's

impacts have been, through careful design which takes into account the character of the communities in which facilities are to be placed. Attention to design details such as landscaping is an important factor in making the transit facilities attractive.

Mitigation of adverse environmental impacts requires that planners make choices among alternatives; environmental, cost and service goals must be considered. For example, BART's environmental impacts have been minimized by the placement of a large portion of the system within existing transportation rights-of-way. Such locations are cost-effective and they minimize the dislocation of residences and businesses. However, they are not always the best locations for rail transit stations in terms of providing convenient access or inducing residential and commercial development. Some compromise solutions may be more effective.

The lack of a lasting BART impact on property prices and rents suggests that a "value capture" policy — a policy designed to tax increases in property values near a transit station which are directly attributable to the system — is unlikely to yield substantial revenues, particularly in the early period of rail transit operations. Although the BART experience suggests that there may be little justification for a financing plan for rail transit which involves a value capture principle, this experience may not be universally applicable. A transit system designed explicitly to attract high-density developments for which there is support from public policies and market demand might induce sufficient increases in land and property prices to justify a value capture policy.

BART's capital costs and the experience of BART in developing a technologically advanced system demonstrate the dilemmas public officials and transit planners face in forecasting costs and devising a financing plan. BART was in the spotlight in the Bay Area, particularly because it was a locally-funded project. Its budgeting, expenditures and operations have been closely scrutinized by local residents. The major causes of financial problems were:

- Original cost estimates were based on existing rates of inflation and on the expectation that construction would proceed without major delays. In fact, inflation rates rose rapidly, particularly in the last few years of the construction period.
- Strikes, lawsuits and negotiations with local communities delayed the construction activities. The cost of each delay was compounded by inflation.
- Additions to the scope of the system in response to community demands increased costs, but these increases were minor when compared with the effects of inflation.

- Increased construction costs led to funding shortages. In an effort to complete the construction of the system with the funds provided, BART eliminated some planned features which would have helped to improve the system's performance. For example, an auxiliary set of trackways in the Oakland junction and some sidings and cross-over trackways were removed from the plans. As a result, the effects of equipment problems have been exacerbated by the lack of facilities for removing malfunctioning trains from the main-line trackways. This has caused frequent service delays throughout the system.

Many of these events could not have been foreseen. Moreover, extremely large contingency provisions in the original budget projections would undoubtedly have been viewed with suspicion by the voters who authorized funding for the system. On the other hand, cost overruns inevitably generate severe criticism and unfavorable attitudes toward public projects.

This aspect of the BART experience demonstrates a need for flexible funding for rail transit systems to provide for unforeseen contingencies during the construction process. However, local governments seldom have the financial resources or the support of local taxpayers for flexible funding. Moreover, it is difficult for a locally-funded operating agency to allocate sufficient time and money to test, debug and retrofit a technologically advanced system such as BART. This suggests that the development of new rail technology is most appropriately accomplished by federally-funded research and development projects, and that federal funding should be made available for unexpected events, such as spiraling inflation, which are beyond a transit agency's control.

The effects of budget constraints and cutbacks in some features of the system continue to affect BART's service today. The service has been unreliable, and patronage levels are lower than anticipated. BART has devoted considerable resources to improving the system's performance, and system reliability has improved. Patronage can be expected to increase, and BART's impacts may become more widespread as service improvements are made.

BART, at its present service and patronage levels, has increased travel capacities and travel in the constrained corridors it serves. A modern rail system such as BART can attract motorists from their cars, and it can capture a significant proportion of the commute-to-work trips made in its primary service area. However, traffic congestion is unlikely to be permanently reduced in the corridors in which a rail transit system is most likely to be built — corridors where travel demand is high and increasing. The highway space made available when motorists switch to a rail transit system will be quickly utilized for other trips in such a situation.

BART is serving a substantial proportion of the trips it was designed to serve best — long-distance trips between suburban areas and central cities. The system has influenced the location of some new construction in the communities it serves. An important benefit which is difficult to measure is BART's symbolic value — the system demonstrates a major public commitment to preserving the vitality of the central Bay Area.

The Impact Program's findings demonstrate that a rail transit system's effects are greatest where other supportive factors are present. These prerequisites include favorable zoning, public improvements, strong market demand, the availability of developable land, and community support. Without these supportive factors a rail transit system is not likely to have an important influence on land use and urban development patterns in a mature metropolitan area that is already highly developed.

As should be expected, the impacts were most pronounced in the primary service area — the corridors served by BART.

The Program found many instances where the design of the system and public policy relative to it had to reconcile conflicting goals or choose between them. In choosing route alignments, trade-offs had to be made between maximizing accessibility — by routing the system through

areas with the greatest densities of residences and businesses — and minimizing environmental impacts. In choosing public development policies, the goals of city planning departments had to be accommodated to the wishes of local residents in some cases, and economic realities in others.

System design and development decisions cannot be made for each station area and line segment separately. The lines and stations form a connected system, and there are goals for the system as a whole that must be reconciled with local concerns.

Where goals conflict and can be reconciled, the solution often requires additional money. The original plans for BART had the system above ground in parts of Berkeley. Berkeley residents wanted it all underground. When there proved to be no other recourse, the voters of Berkeley approved a local tax to finance the undergrounding of the line within the city limits, and the plans were changed.

The BART experience illustrates the principle that design and development choices made for one rapid transit system, or even for parts of the same system in different localities, cannot be prescribed for other localities. The Impact Program's findings, which are documented in this and other reports, indicate the consequences of a number of alternatives, but choices must be made on the basis of individual communities' priorities and needs.

7 Technical Literature

These MTC publications provide further information about the BART Impact Program. All of them are available from the National Technical Information Service (Springfield, Virginia).

BART in the San Francisco Bay Area

Report No. DOT-BIP-FR 9-201-78

This is the final report of the BART Impact Program. It summarizes and integrates the findings of the program's several projects.

Environmental Impacts of BART: Final Report

Report No. DOT-BIP-FR 7-4-77

BART's First Five Years: Transportation and Travel Impacts

Report No. DOT-BIP-FR 11-3-78

The Impact of BART on Public Policy: Final Report

Report No. DOT-BIP-FR 13-8-78

Impacts of BART on Bay Area Institutions and Life Styles: Final Report

Report No. DOT-BI-FR 10-6-77

The Economic and Financial Impacts of BART: Final Report

Report No. DOT-BIP-FR 8-7-77

The Impact of BART on Land Use and Urban Development: Final Report

Report No. DOT-BIP-FR 14-5-78

The Local Policy Implications of BART Development: Final Report

Report No. DOT-BIP-FR 15-8-78

The Implications of BART's Impacts for the Transportation Disadvantaged: Final Report

Report No. DOT-BIP-FR 12-10-78

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<i>Environment Project</i>	Gruen Associates and DeLeuw Cather & Co.
<i>Transportation Systems and Travel Behavior Project</i>	Peat, Marwick, Mitchell & Co.
<i>Land Use and Urban Development Project</i>	John Blayney Associates and David Dornbusch & Co.
<i>Economics and Finance Project</i>	McDonald & Grefe, Inc.
<i>Institutions and Life Styles Project</i>	Jefferson Associates
<i>Public Policy Project</i>	Booz, Allen & Hamilton, Inc.
<i>Implications for the Transportation Disadvantaged Project</i>	Urban Dynamics Associates

